Exploration Marathon

STS-78 crew conducts variety of JSC tests to prepare for longer flights

While the record-setting 17-day mission of Space Shuttle *Columbia* ended Sunday, the research has only just begun as scientists at JSC and around the world begin sifting through the mountain of data STS-78 accumulated.

"Overall, in terms of life sciences, the information gathering has just been tremendous," said Victor Schneider, life and microgravity program scientist at NASA Headquarters.

"We have 41 principal investigators involved with the mission, and all but very few have 100 percent, if not 200 percent of the data they had hoped to collect," added Mission Scientist J. Patton Downey.

Two investigations aboard Spacelab originated with JSC researchers, who are anxious to begin reviewing the data.

The Canal and Otolith Integration Study, focused on the effects of microgravity on the vestibular system of the inner ear. Principal Investigator Millard Reschke of JSC's Space Biomedical Research Institute said this "basic science" could provide new clues about how the brain, the inner ear and eyes work together to orient people in their environment.

"We've gotten information and perceptions from the crew that we've never seen before," Reschke said. "Many times people believe what they see is really true, particularly with how they're oriented in their environment. We're finding that what they see may actually be completely opposite of what is true. The brain is taking the perception and making responses of the head and eye that compensate for perception."

In space, the vestibular system becomes confused as to which way is up and down, leading to nausea and disorientation. Using specially designed head gear and a target projection system to monitor head movement and eye coordination, crew members performed tests to determine how the head and eyes track visual and motion targets in microgravity.

The studies were included in the Voluntary Head Movements experiment and the Optokinetic Nystagmus experiment. During this investigation, crew members wore high-tech modified ski goggles, known as an optokinetic nystagmus apparatus, to help record their eye and head movements as they tracked illuminated targets.

Both experiments were performed pre-flight to establish a defined Earth-stable baseline, and are being repeated post-flight to track the recovery process. Repeated measurements were made this past week for comparison to those obtained before and during the flight.

All of the data taken during the flight still is stored on tapes and has not been delivered to Reschke and his team. He said he hopes to have the tapes and begin evaluation within a week, but that already the comparison of pre-flight and post-flight measurements is yielding interesting results.

"We're looking primarily at the interaction of the visual and vestibular system in the pursuit tracking system. All of these things are needed to hold images stable in front of the eye, and all are relying on the inner ear to provide that," he said. "On post-flight data, we've seen extremely large changes in the ability of the crew to do this. This is verification that on a long flight these kinds of things are directly related to the duration of the flight."

Reschke said the experiment hardware performed exceptionally well, in particular the hardware provided through the French space agency, CNES. Co-investigators included Alain Berthoz, Centre National de la Recherche Scientifique/College de France, Paris; Gilles Clement, CNRS, Toulouse, France; Bernard Cohen, Mount Sinai Medical Center; Makoto Igarashi, Nihon University in Toykyo; William Paloski, of the Space Biomedical Research Institute; and Donald Parker, University of Washington in Seattle.

Reschke said that, for the first time, the COIS researchers were able to follow the experiment protocols through television and photographic coverage, which provided visual verification that the protocols were being followed properly.

"The crew did exceptionally well," he said. "This crew in particular was asked to do a lot and they were really instrumental in carrying out science where they didn't have a lot of opportunity to interact with investigators for feedback. That was primarily due to their training, and one of the most dedicated payload commanders that we've ever worked with."

Reschke said the research has implications for many people on Earth who suffer from conditions that create dizziness and other perceptual problems. He said Oliver Sacs, the well known author of "The Man Who Mistook his Wife for a Hat?" and the doctor in the movie, "Awakenings," has said that the only way to truly understand problems of orientation, balance and the inner ear is to fly people in space and remove constant gravitational stimulation.

Another JSC-based experiment, the Magnetic Resonance Imaging After Exposure to Microgravity, used two different body scanning systems to test the effects of microgravity on muscles and other tissues.

Principal Investigator Adrian LeBlanc, who works here at JSC with Krug Life Sciences, Methodist Hospital and Baylor College of Medicine, said researchers are looking for the causes of back pain some astronauts experience when in space and at ways of may help scientists fight certain muscle diseases and osteoporosis on Earth.

Working with him were co-investigators Linda Shackleford of JSC's Medical Sciences Division;, Harlan Evans, also with Baylor and Krug Life Sciences; Chen Lin and Steward West of Baylor; and Thomas Hendrick of Methodist Hospital.

In the past, longer duration shuttle flights have revealed evidence of significant losses in calf, thigh and lower back muscles, and other tissues. Before and after this flight, researchers performed Magnetic Resonance Imaging, or MRI, and Dual Energy X-Ray Absorbtiometry, or DEXA, scans on the crew members to document changes in the volume of individual muscles, the degree of atrophy and the rate of recovery to preflight status.

"We are also examining the changes in the intervertebral discs," said LeBlanc. "Astronauts report they are taller in space, which can in part be explained by expansion in these discs. We are trying to see the degree of disc expansion in microgravity and subsequent return to normal once back on Earth."

From this, LeBlanc said, researchers hope to improve their understanding of the causes of the back pain reported by some crew members on orbit.

"We are also measuring marrow composition which may be related to red cell mass changes seen in previous space flights," he said.

The MRI and DEXA scans were performed 60 and 30 days before launch and again repeated on landing day, and again between 40 and 72 hours. They'll be repeated two weeks from landing, and again between four and five weeks after the mission's end.

The JSC experiments were just two of the 41 investigations aboard *Columbia.* An international team of researchers from NASA, the European Space Agency and colleges and universities across the United States, Canada and Europe monitored and remotely controlled many of the experiments as the crew helped conduct or process them. This was the most extensive use of "remote telescience" in shuttle program's history.

According to Mission Manager Mark Boudreaux, the ability of investigators to remotely control and monitor experiments from four remote European and four remote domestic locations is a key aspect of the upcoming International Space Station era. Thanks to Spacelab, scientists can plan on using the now proven technology to manipulate experiments in space from their own research centers.

Information gathered aboard STS-78 from the life sciences experiments aboard Spacelab will prove vital to future science missions as well as life aboard space station.

Numerous experiments meant to gather information on muscle strength, endurance, mental fatigue, muscle tissue loss and sleep cycles were conducted on orbit.

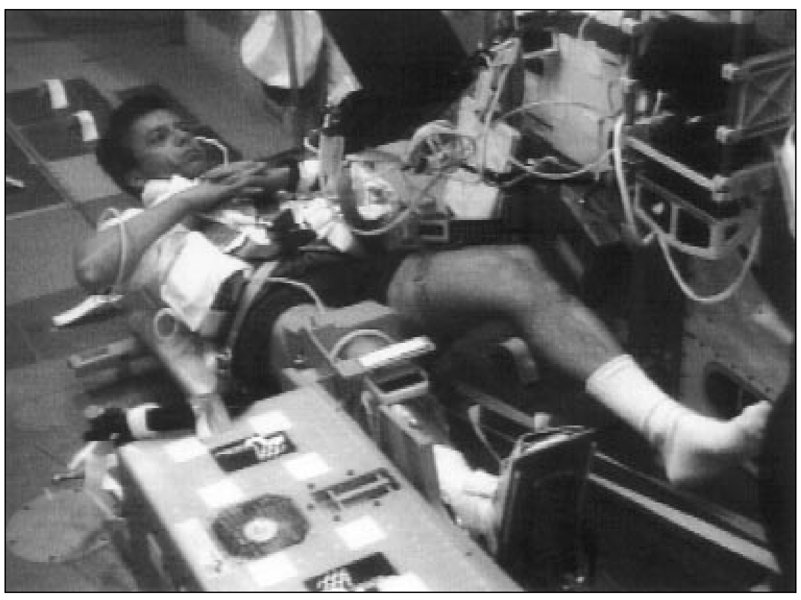
Researchers can now compare the results with the baseline information gathered while the crew was on Earth to determine the physiological effects of living in a microgravity environment. Investigators will gain insight on how to develop ways to help astronauts maintain their muscle strength and endurance not only on shuttle missions, but also during future long duration mission aboard space station or, perhaps someday, a mission to Mars.

STS-78 marked the first time researchers collected biopsy muscle tissue from crew members both before and after the flight. Crew members provided muscle biopsy samples and underwent MRI and DEXA scans almost immediately after landing at Kennedy Space Center.

The findings from the comparison of biopsy samples, along with the musculoskeletal tests conducted on orbit, may help scientists develop measures to reduce in-flight muscle atrophy and also combat muscle disease and osteoporosis on Earth.

Another vital "first" on this mission was the beaming of video images to the shuttle to help crew members perform in-flight maintenance procedures. Engineers at JSC worked with private vendors to adapt a commercial video teleconferencing software to the shuttle Ku-band communications system, which allowed for the two-way transmissions.

"The video conferencing has really been outstanding," Pilot Kevin Kregel reported. "We used it to fix the Bubble Drop and Particle Unit Experiment, and it made fixes a lot easier." ❑



Above: Mission Specialist Rick Linnehan, assisted by Payload Commander Susan Helms, participates on-orbit in the JSC-based Canal and Otolith Integration Study investigation, a neuroscience experiment, studying changes in the coordination of head and eye movements associated with adaptation to microgravity. Bottom left: Canadian Payload Specialist Bob Thirsk uses the Torque Velocity Dynamometer during the mission to measure the mechanical power of arm and leg muscles. Bottom right: French Payload Specialist Jean-Jacques Favier, wearing the Torso Rotation Experiment device, completes a neuroscience experiment as he monitors rotational movements of the eye, head and upper torso to determine if the normal activity patterns are changed as a result of prolonged exposure to weightlessness.